ADVANCED AND EVER ADVANCING **MITSUBISHI ELECTRIC**

MITSUBISHI

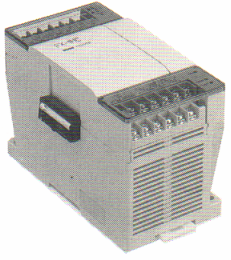
PROGRAMMABLE CONTROLLERS

MELSEC-F

FX

FX-1HC

USER'S MANUAL



FOREWORD

- This manual provides technical information on the use of this special function block in connection with the FX programmable controller.
- Users should ensure that the details of this manual is studied and understood before attempting to install or use these units.

CONTENTS

1.	INTRODUCTION	1
2.	CONFIGURATION AND SPECIFICATIONS	2
3.	CONNECTION, WIRING	5
4.	ASSIGNMENT OF BUFFER MEMORY	7
5.	COUNTER MODES (BFM #0 to #3)	10
6.	COMMAND SETTINGS (BFM #4 to #15)	13
7.	CURRENT VALUE, STATUS INFORMATION (BFM #20 to #30)	15
8.	REQUIRED PROGRAMMING	18
9.	OPERATION, ABNORMALITY CHECK	19
10.	OUTLINE OF FROM/TO INSTRUCTION	20

1. INTRODUCTION

The FX-1HC hardware high-speed counter block is a 2-phase 50 kHz high-speed counter. It is a special extension block for the FX series programmable controller. The FX-1HC counts at a higher speed than the built-in high-speed counter of the programmable controller (2-phase 2 kHz, 1-phase 10 kHz) and performs comparisons and outputs directly.

(1) Compatible PCs

Versions 2.0 or later of the FX series of programmable controllers (those with serial nos. 13XXXX or larger) may be used with the FX-1HC. This is because the FROM and TO commands are used to transfer data between the programmable controller base unit and the FX-1HC.

(2) Unit Configuration

The casing of the FX-1HC unit resembles that of the 16 I/O point extension block, but the number of I/O points occupied by the FX-1HC is actually eight (you can count them as either input or output points). The FX-1HC unit consumes 70mA of the 5V power supplied by the programmable controller, so you must take care to keep the total power consumed by all the extension blocks below the allowable limit of your programmable controller. The output circuit of your encoder or the transistor outputs of this special block will require a separate power source.

(3) Input Signal

The source of your input signal should be a 1 or 2 phase encoder. A 5V, 12V, or 24V power source can be used. An initial value setting command input (PRESET) and a count prohibit command input (DISABLE) are also available.

(4) Transistor Output

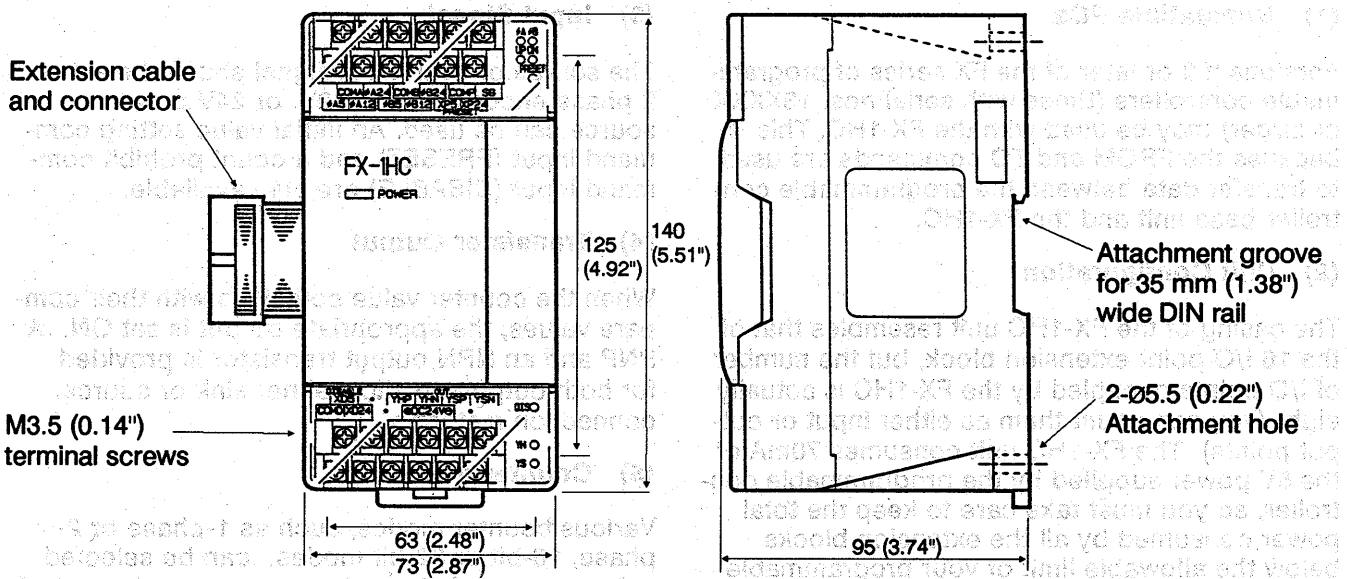
When the counter value coincides with their compare values, the appropriate output is set ON. A PNP and an NPN output transistor is provided for both outputs to allow either sink or source connection methods.

(5) Counter mode

Various counter modes, such as 1-phase or 2-phase, 16-bit or 32-bit modes, can be selected using commands from the programmable controller. Allow the FX-1HC unit to run only after setting these mode parameters.

2. CONFIGURATION AND SPECIFICATIONS

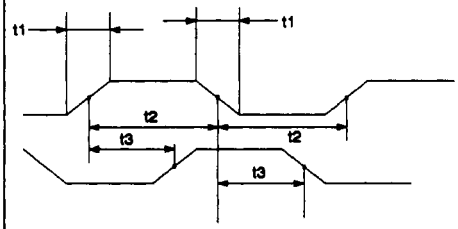
- Weight: Approx. 0.5 kg
- Dimension mm (inches)
- Accessories: Self-adhesive labels for special block number identification



2. CONFIGURATION AND SPECIFICATIONS

Performance Specifications

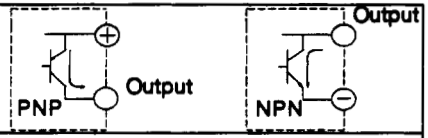
The environmental specifications for the FX-1HC are the same as those for your base unit of the FX series.

<table>
<tr><td colspan="2" rowspan="2">Item</td><td colspan="2">1-phase input</td><td colspan="3">2-phase input</td></tr>
<tr><td>1 input</td><td>2 inputs</td><td>1 edge count</td><td>2 edge count</td><td>4 edge count</td></tr>
<tr><td rowspan="3">Input signal</td><td>Signal level</td><td colspan="5">5V, 12V, or 24V +/-10% (selected by terminal connection) 7mA</td></tr>
<tr><td>MAX frequency</td><td colspan="3">50 kHz</td><td>25 kHz</td><td>12.5 kHz</td></tr>
<tr><td>Pulse shape</td><td colspan="5"> 

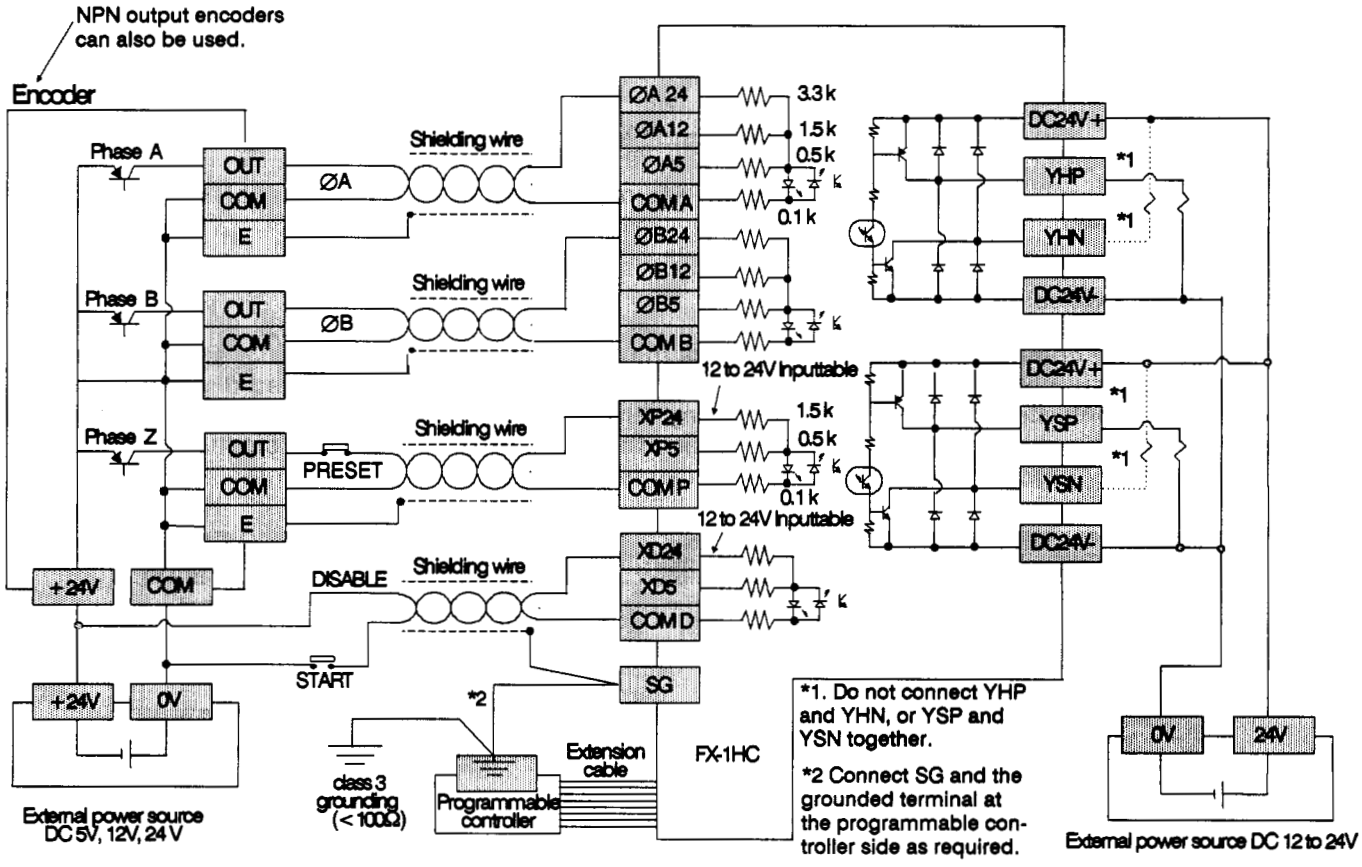
t1: Rise/fall time is 3μs or less
t2: ON/OFF pulse duration 10μs or more
t3: Phase difference between phase A and phase B is 3.5μs or more
PRESET (Z phase) input 100μs or more
DISABLE (count prohibit) input 100μs or more</td></tr>
<tr><td rowspan="3">Counting specification</td><td>Format</td><td colspan="5">Automatic UP/DOWN (however, when on 1 phase 1 input mode, UP/DOWN is determined by a programmable controller command or an input terminal.)</td></tr>
<tr><td>Range</td><td colspan="5">When 32-bit is specified: -2,147,483,648 to +2,147,483,647
When 16-bit is specified: 0 to 65,535 (upper limit can be user specified)</td></tr>
<tr><td>Comparison Type</td><td colspan="5">Each output is set when the present value of the counter matches with the compare value (which is transferred from the programmable controller), and is switched OFF by a reset command from the programmable controller.

YH: Direct output processed by hardware.
YS: Software processed output with worst delay time of 300μs.
(Therefore, when the input frequency is 50 kHz, there is a worst case delay of 15 input pulses.)</td></tr>
</table>

2. CONFIGURATION AND SPECIFICATIONS

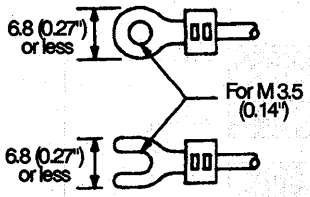
Output Signal	Types of outputs	YHN: NPN transistor output for YH output YHP: PNP transistor output for YH output YSN: NPN transistor output for YS output YSP: PNP transistor output for YS output	
	Output capacity	DC 12V to 24V 0.5A	
I/O Occupation		8 points (but not addressed by X, Y relays)	
Power From Base		DC 5V 70mA	

3. CONNECTION, WIRING



3. CONNECTION, WIRING

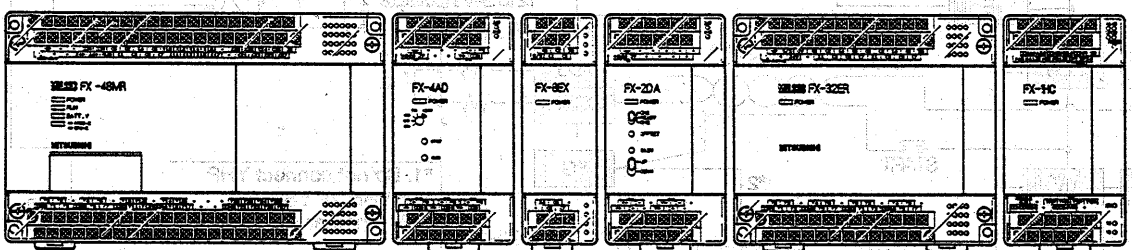
< Using the solderless termination >



- Use crimp terminals of the dimensions specified in the left figure.
- Secure the terminals using a tightening torque of 5 to 8kg·cm.
- Wire only to the module terminals discussed in this manual. Leave all others vacant.

Use with other extension blocks

The FROM and TO commands are used by most of the Special Function Blocks, (e.g. analog input blocks, analog output blocks, high-speed counter blocks). These may be connected directly to the FX Programmable Controller's extension port or to any other extension unit's right side extension port. Each unit or block is consecutively numbered from 0 to 7 beginning from the one closest to the base unit. A maximum of eight special function blocks can be connected to one base unit.



FX-48MR X0 to X27 Y0 to Y27 | FX-4AD Special block No.0 | FX-8EX X30 to X37 | FX-2DA Special block No.1 | FX-32ER X40 to X57 Y30 to Y47 | FX-1HC Special block No.2

4. ASSIGNMENT OF BUFFER MEMORY

BFM number	Contents	
*W #0	Counter mode K0 to K11	Default: K0
*W #1	DOWN/UP command (1-phase 1-input mode)	Default: K0
*W #2	Ring length Lower 16 bits	Default: K65,536
*W #3	Ring length Upper 16 bits	
*W #4	Command	Default: K0
#5 to #9	Cannot be used	
*W #10	Preset data Lower 16 bits	Default: K0
*W #11	Preset data Upper 16 bits	
*W #12	YH compare value Lower 16 bits	Default: K32,767
*W #13	YH compare value Upper 16 bits	
*W #14	YS compare value Lower 16 bits	Default: K32,767
*W #15	YS compare value Upper 16 bits	
#16 to #19	Cannot be used	
*R/W #20	Counter current value Lower 16 bits	Default: K0
*R/W #21	Counter current value Upper 16 bits	
*R/W #22	Maximum count value Lower 16 bits	Default: K0
*R/W #23	Maximum count value Upper 16 bits	
*R/W #24	Minimum count value Lower 16 bits	Default: K0
*R/W #25	Minimum count value Upper 16 bits	
#26	Compare results	
#27	Terminal status	
#28	Cannot be used	
*R #29	Error status	
#30	Model identification code K4010 is written	
#31	Cannot be used	

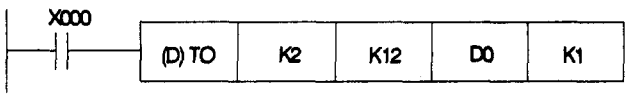
4. ASSIGNMENT OF BUFFER MEMORY

Data transfer between the FX-1HC block and the Programmable Controller is through the FX-1HC's RAM buffer memory (32 address locations each of 16 bits) by the controller's FROM/TO instructions.

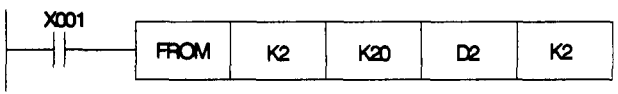
With reference to the table on the previous page:

- W: These settings determine how the counting and the setting or resetting of the output is made. The FX base unit should write to these areas before starting any count process.
- R: These areas are for monitoring purposes. They are read only areas in which data can be read by the FROM instruction but cannot be written by the TO instructions. If the TO instruction is attempted on these areas, the instruction is ignored.
- R/W: These areas are read and writable. They can be read for monitoring purposes. They can also be written to for resetting. Care should be taken when writing to these areas as the current data will be lost.

• Write/read examples

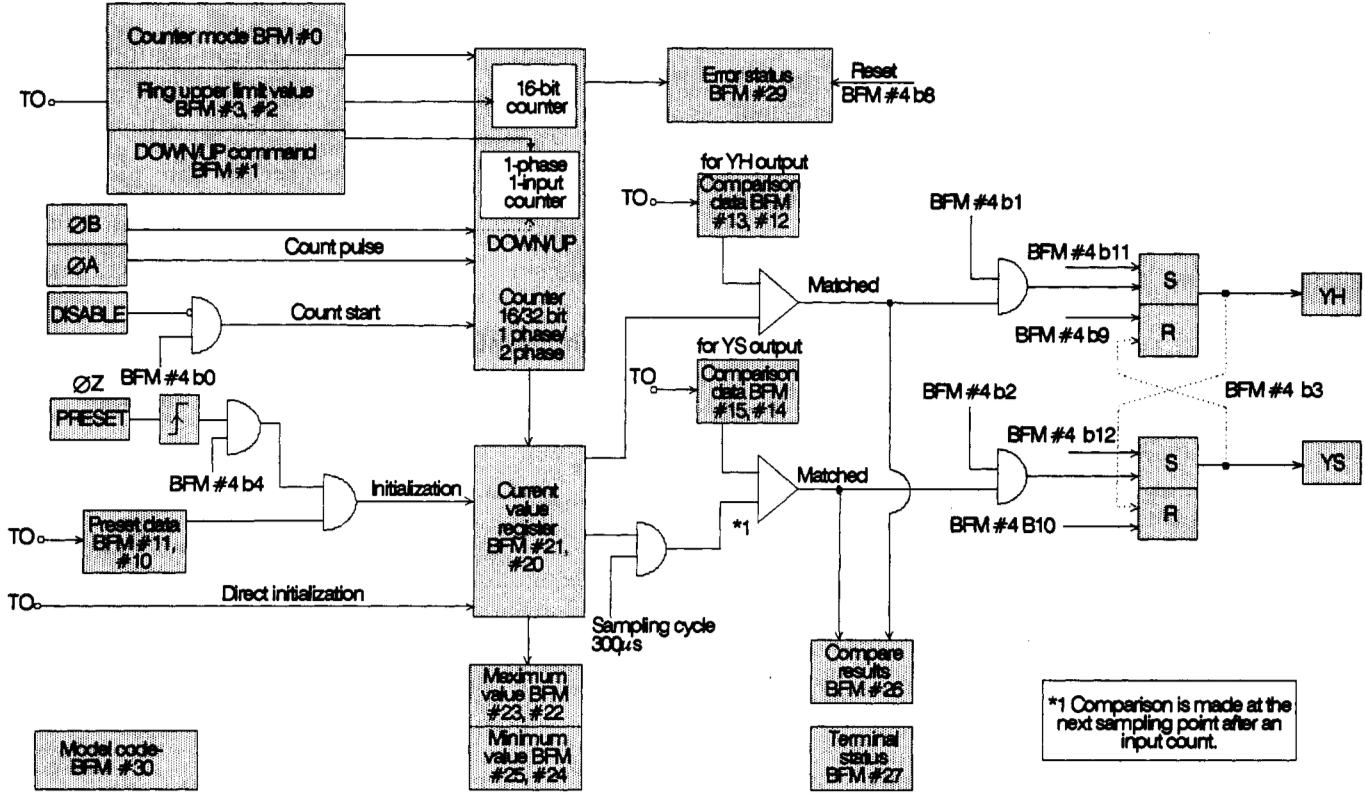


The contents of data registers D1 and D0 are written into BFMs #13 and #12 of special block No.2.



The contents of BFMs #21 and #20 of special block No.2 are read to data registers D3 and D2.

4. ASSIGNMENT OF BUFFER MEMORY



5. COUNTER MODES (BFM #0 to #3)

(1) BFM #0 Counter mode

The counter mode is selected from the programmable controller. As shown below, values between K0 and K11 are written to buffer memory BFM #0 from the programmable controller. When you are about to begin, you must give a momentary command using M8002 (initial pulse) as the condition contact of the TO instruction. A continuous command is not allowed.

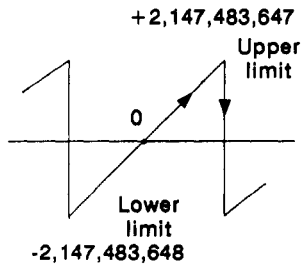
Modes of K0 to K11 of buffer memory BFM #0

Count Modes		32 bits	16 bits
2-phase input (phase difference pulse)	1 edge count	K0	K1
	2 edge count	K2	K3
	4 edge count	K4	K5
1-phase 2-input (add/subtract pulse)		K6	K7
1-phase 1-input	H/W UP/DOWN	K8	K9
	S/W UP/DOWN	K10	K11

H/W: Hardware

S/W: Software

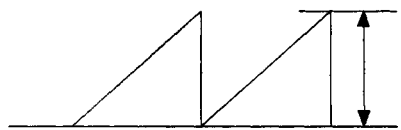
(a) 32-bit counter modes



A 32-bit binary counter which executes UP/DOWN counting will change from the lower limit to the upper limit or the upper limit to the lower limit when overflow occurs. Both the upper and lower limits are fixed values: the upper limit is +2,147,483,647, and the lower limit is -2,147,483,648.

(b) 16-bit counter modes

A 16-bit binary counter handles only positive values from 0 to 65,535.



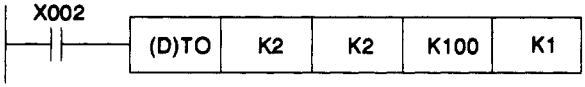
Ring length (BFM #3, #2)

Changes to zero from the upper limit or to the upper limit from zero when overflow occurs; the upper limit is determined by BFMs #3 and #2.

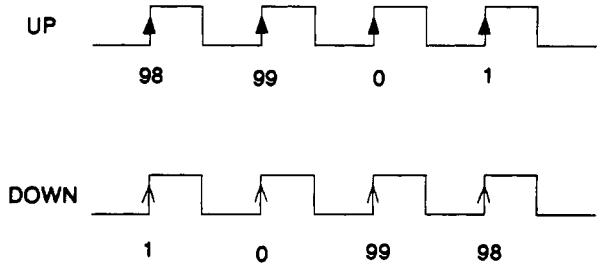
5. COUNTER MODES (BFM #0 to #3)

(2) BFM #3, #2 Ring length

Stores the data to specify the length of the 16-bit counter (default: K65,536).



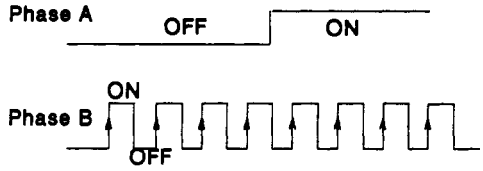
In the above example, K100 is written into BFMs #3 and #2 of special block No.2 as a 32-bit binary value (BFM#3 = 0, BFM#2 = 100). Permitted values: K2 to K65,536.



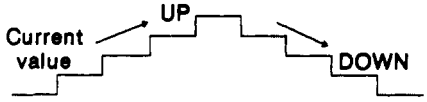
When ring length K100 is specified, the value of the counter changes as shown above.

(3) 1-phase 1-input counter (K8 to K11)

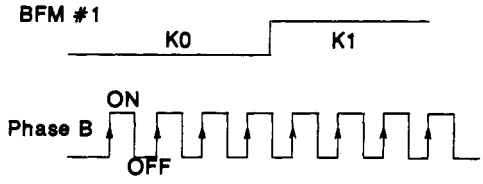
- Hardware UP/DOWN (K8 , K9)



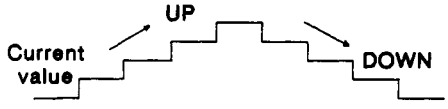
UP/DOWN is determined by input phase A (ON/OFF).



- Software UP/DOWN (K10, K11)

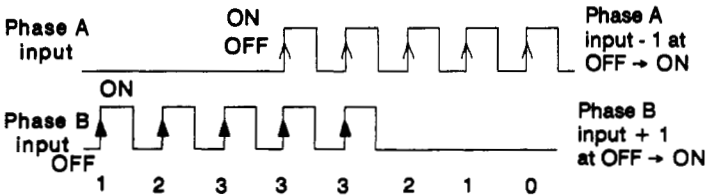


UP/DOWN is determined by the contents of BFM #1, (K0/K1).



5. COUNTER MODE (BFM #0 to #3)

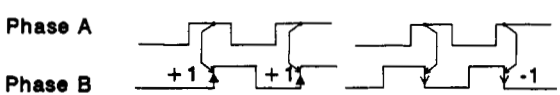
(4) 1-phase 2-input counter (K6, K7)



If both phase A and phase B inputs are received simultaneously, the counter value does not change.

(5) 2-phase counter (K0 to K5)

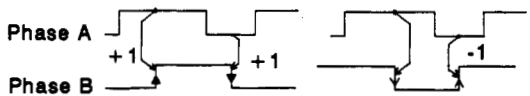
- 1 edge-count-counter (K0, K1)



Phase B input OFF→ON while phase A input ON Count up by 1.

Phase B input ON→OFF while phase A input ON Count down by 1.

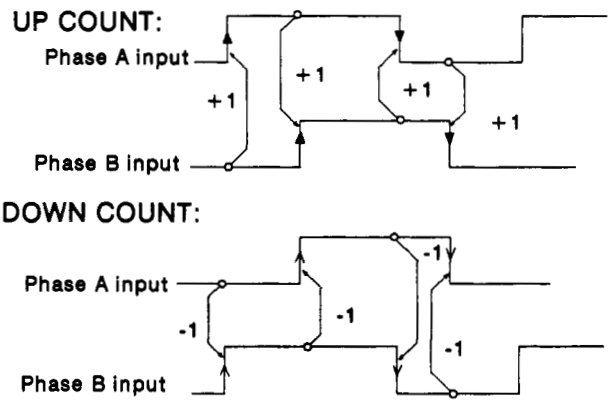
- 2 edge-count counter (K2, K3)



Phase B input OFF → ON (ON → OFF) Count up by 1 each change.

Phase B input ON →OFF (OFF →ON) Count down by 1 each change.

- 4 edge-count counter (K4, K5)



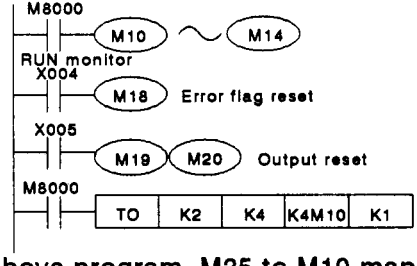
6. COMMAND SETTINGS (BFM #4 to #15)

(1) BFM #4 Command

BFM #4	When '0' (OFF)	When '1' (ON)
b0	Count prohibit	Count permit
b1	YH output prohibit	YH output permit
b2	YS output prohibit	YS output permit
b3	YH/YS independent action	Mutual reset action
b4	Preset prohibit	Preset permit
b5 to b7	Undefined	
b8	No action	Error flag reset
b9	No action	YH output reset
b10	No action	YS output reset
b11	No action	YH set
b12	No action	YS set

1. When b0 is set to ON and the DISABLE input terminal to OFF, the counter is permitted to start counting input pulses.
2. Unless b1 is set to ON, YH (hardware compared output) does not turn ON.
3. Unless b2 is set to ON, YS (software compared output) does not turn ON
4. When b3 = ON, YS output is reset if YH output is set, and YH output is reset if YS output is set. When b3 = OFF, YH and YS outputs act independently, and do not reset each other.
5. When b4 = OFF, preset function from the PRESET is disabled
6. When b8 is set to ON, all error flags are reset.
7. When b9 is set to ON, YH output is reset.
8. When b10 is set to ON, YS output is reset.
9. When b11 is set to ON, YH output is set ON.
10. When b12 is set to ON, YS output is set ON.

< Example Program >



In the above program, M25 to M10 map onto b15 to b0 of BFM #4 of special block No.2.

b4 to b0 are turned ON at all times by M14 to M10.

b8 (M18), b9 (M19), and b10 (M20) are controlled by the programmable controller inputs X004 and X005.

6. COMMAND SETTINGS (BFM #4 to #15)

(2) BFM #11, #10 Preset data

- Data to be used as the initial value when the counter starts to count.
- Data becomes valid when b4 is set to ON, and PRESET input terminal changes from OFF to ON. The default value of the counter is zero. You can change it by writing a value into BFM #11 and #10 or by using the above command.
- The initial value can also be set by writing the data directly into BFM #21 and #20 (current value of the counter).

Write counter data with (D) TO

- Count data is always handled as a pair from two 16-bit values in this special counter block. 16-bit 2's complement values stored in the registers of the programmable controller cannot be used.
- When you are writing a positive value between K32,768 and K65,535, the data should be treated as a 32-bit value even when a 16-bit ring counter is used.
- When transfering counter data to/from this special counter block, always use the 32-bit forms of the FROM/TO instructions ((D)FROM, (D)TO).

(3) BFM #13, #12 Compare value for YH output

- After comparing the current value of the counter with the value written in BFM #13 and #12, the hardware comparator in the FX-1HC outputs the comparison result.
- YH output will not turn ON if you use the preset or the TO instruction to set the preset value equal to the counter value. It will turn ON only when a match occurs by the counting of input pulses.

(4) BFM #15, #14 Comparison set value for YS output

- After comparing the current value of the counter with the value written into BFM #15 or #14, the software comparator in the FX-1HC outputs the comparison result.
- The comparison operation takes about 300μs, and if a match occurs, the output goes ON.
- The output will not turn ON if you use the preset or the TO instruction to set the preset value equal to the counter value. It will turn ON only when a match occurs by the counting of input pulses.

7. CURRENT VALUE, STATUS INFORMATION (BFM #20 to #30)

(1)Counter current value (BFM #21, 20)

The current value of the counter can be read by the programmable controller. It will not be the correct value during high-speed operations because of the communication delay. The current value of the counter can be forcibly changed by writing a 32-bit value into the appropriate BFMs from the programmable controller. Although a match may occur while you are rewriting, you will not get an output.

(2)Maximum count value (BFM #23, 22)

These store the maximum and minimum values reached by the counter. If the power is turned off, the stored data is cleared.

(3)Comparison status (BFM #26)

BFM #26		When '0' (OFF)	When '1' (ON)
YH	b0	Set value≤current value	Set value > current value
	b1	Set value≠current value	Set value = current value
	b2	Set value≥current value	Set value < current value
YS	b3	Set value≤current value	Set value > current value
	b4	Set value≠current value	Set value = current value
	b5	Set value≥current value	Set value < current value

BFM #26 is only for reading only. Write commands from the programmable controller are ignored.

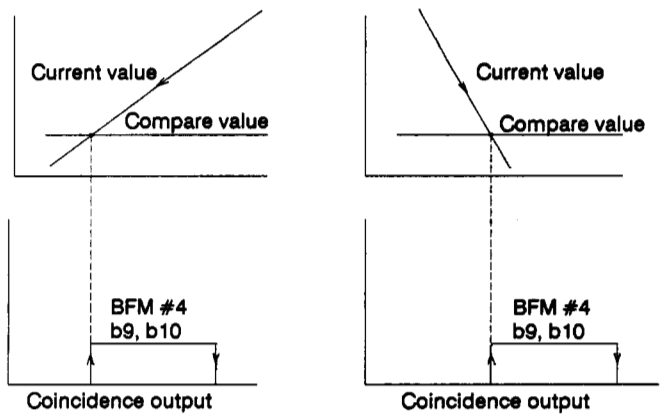
7. CURRENT VALUE, STATUS INFORMATION (BFM #20 to #30)

(4) Terminal status (BFM #27)

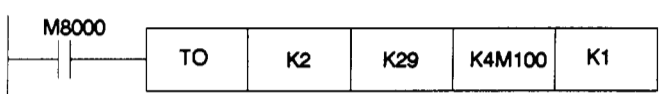
BFM #27	When '0' (OFF)	When '1' (ON)
b0	PRESET input is OFF	PRESET input is ON
b1	DISABLE input is OFF	DISABLE input is ON
b2	YH output is OFF	YH output is ON
b3	YS output is OFF	YS output is ON
b4 to b15	Undefined	

1. When BFM #4 b4 = 1, the contents of BFMs #11 and #10 are written into the current value register of the counter immediately after the PRESET terminal changes to ON.
2. When BFM #4 b0 = 1, counting starts immediately after the DISABLE terminal changes to OFF.
3. Output occurs when the current value becomes equal to the compare value but only if b1 and b2 of BFM #4 are OFF. Once an output is set, it remains ON until it is reset by b9 or b10 of BFM #4. If b3 of BFM #4 is ON, however, one of the outputs is reset when the other is set.

(5) BFM #29 Error status



Error status in the FX-1HC can be checked by reading the contents of b0 to b7 of BFM #29 to auxiliary relays of the programmable controller.



Special block No.2 BFM #29 (b7 to b0) →(M107 to M100)

7. CURRENT VALUE, STATUS INFORMATION (BFM #20 to #30)

BFM #29	Error status	
b0	Set when any of b1 to b7 is ON.	
b1	Set when the value of the ring length is written incorrectly. (other than K2 to K65,536)	
b2	Set when the current value is written incorrectly.	When value ≥ ring length in 16-bit counter mode
b3	Set when the compare value is written incorrectly.	
b4	Set when the current value is written incorrectly.	
b5	Set when the counter overflows the upper limit.	When the upper or lower limit is exceeded on a 32-bit counter
b6	Set when the counter overflows the lower limit.	
b7	Set when the FROM/TO command is used incorrectly.	
b8 ~b15	Undefined	

These error flags can be reset by b8 of BFM #4.

(6) Model identification code number BFM#30

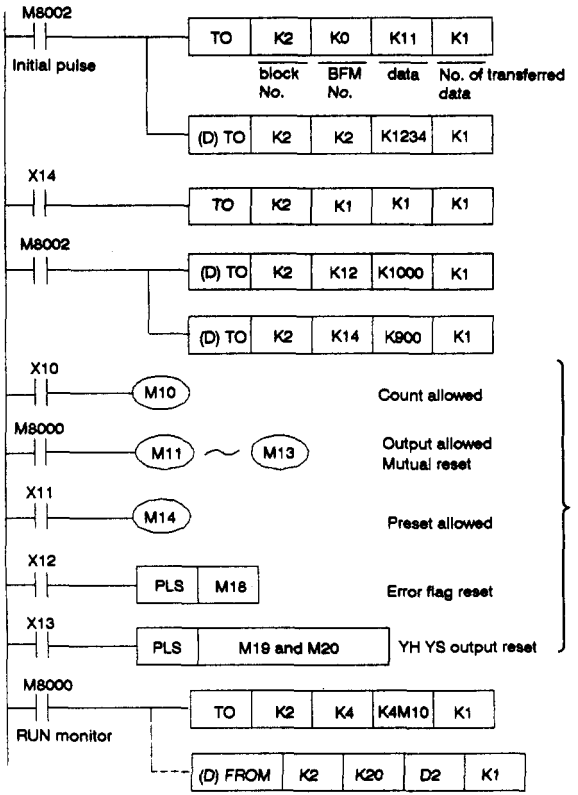
The identification number for a Special Block is read by using the FROM command.

The identification number for the FX-1HC unit is K4010.

By reading this identification number, the user may create built-in checking routines to check whether the physical position of the FX-1HC matches to that of the software.

8. REQUIRED PROGRAMMING

Please use the following program as a guide whenever you use the FX-1HC unit. Other instructions to read the current value of the counter, status etc. can be added as required.



1. K11 is written into BFM #0 of special block No.2. The counter input is 16-bit 1-phase. Please use a pulse command for this initialization.
2. K1234 → BFM #3, #2 (special block No.2) The ring length can be specified when a 16-bit counter is specified.
3. UP/DOWN direction should be specified for 1-phase 1-input software determined UP/DOWN counter.
4. K1000 → BFM #13, #12 Set the compare value for YH output
5. K900 → BFM #15, #14 Set the compare value for YS output (not necessary if only YH output is used).
6. Note that counting only occurs if count prohibit is OFF. Also, outputs will not be set from the counting process at all if the relevant output prohibit are set in the command register. Please reset the error flags and YH/YS output before you start. The mutual reset and preset initialization commands can be used as required.
7. (M25 to M10) → BFM #4 (b15 to b0) command
8. BFM (#21, #20) → Reads the current value to the data registers D3 and D2.

9. OPERATION, ABNORMALITY CHECK

<Preliminary Checks>

1. Check that the I/O wiring and extension cable of the FX-1HC are properly connected.

2. 5V 70mA power is supplied from the base or extension units for the FX-1HC. Check that there is no power overload from this and other extension blocks.

3. The counter works correctly only when data such as the counter mode (set with a pulse command),the TO command, the compare value, etc. are appropriately specified. Remember to initialize the count (BFM #4 b0), preset (BFM #4 b4), and output (BFM #4 b2,b1) prohibits. Reset the YH/YS outputs before you start.

< Troubleshooting >

The following LEDs on the main panel of the FX-1HC may help you to troubleshoot the unit.

- ϕA, ϕB

  Goes on/off as ϕA, ϕB input turn ON/OFF. It can be checked by rotating the encoder slowly.

- UP, DN

  Lights up to indicate whether the counter is going up (UP) or down (DN).

- PRESET and DIS

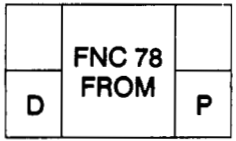
  The appropriate LED lights up when the PRESET terminal or the DISABLE terminal is ON.

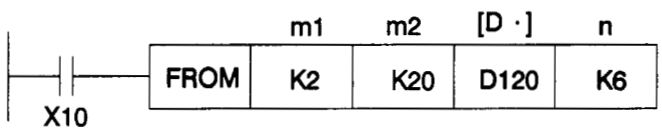
- YH, YS

  The appropriate LED lights up when YH/YS output is turned on.

You can check the error status by reading the content of BFM #29 to the programmable controller. Error contents are shown on page 17.

10. OUTLINE OF FROM/TO INSTRUCTION





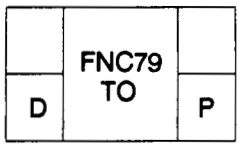
BFM #20 to #25 of special unit No. 2 → D120 to D125

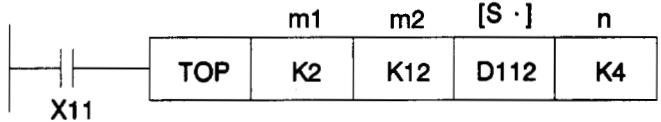
m1: Special function unit or block number. These are numbered consecutively from K0 to K7 starting from the one closest to the base unit.

m2: Buffer memory head address. (m2 = K0 to K31)

[D·]: Transfer destination head address. T, C, D, KnM, KnY, KnS, V or Z can be specified. This argument can be coupled with an index register.

n: The number of words to be transferred (n = K1 to K32)





D112 to D115 transferred to special block No.0 BFM #12-#15

m1, m2, n: The same as above

[S·]: Transfer destination head address. T, C, D, KnX, KnY, KnM, KnS, V, Z, K or H can be specified. This argument can be coupled with an index register.

When X10 or X11 is OFF, transfer is not executed, and data at the transfer destination will not be changed.

Revisions

EDITION DATE	MANUAL NUMBER	REVISION
Jun. 1991	JY992D27301A	First edition
Aug. 1991	JY992D27301B	P.3 5 → 3.5μs. P.11 initial value → default. P.12 (4) waveform corrected. P.13 comparator O/P →output. P.17 b_2 - b_4 of table changed.
Apr. 1992	JY992D27301C	P.7 BFM #20, 21 : *R → *R/W.
Sept. 1993	JY992D27301D	Text change : P. 1, 7, 13, 17. Chapter 8 title : P. 18. R/W text : P. 7, 8.

Under no circumstances will Mitsubishi Electric be liable or responsible for any consequential damage that may arise as a result of the installation or use of this equipment.

All examples and diagrams shown in this manual are intended only as an aid to understanding the text, not to guarantee operation. Mitsubishi Electric will accept no responsibility for actual use of the product based on these illustrative examples.

Owing to the very great variety in possible applications of this equipment, you must satisfy yourself as to its suitability for your specific application.

MITSUBISHI ELECTRIC CORPORATION

HEAD OFFICE: MITSUBISHI DENKI BLDG MARUNOUCHI TOKYO 100 TELEX: J24532 CABLE MELCO TOKYO
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JY992D27301D
HI-IB-057-D (9309) (SEN) (D1)

Effective SEP. 1993
Specifications are subject to change without notice.